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INVESTIGATION OF THE EFFECT OF OPERATION OF HIGH-VOLTAGE IMPULSES--ETC(U)  
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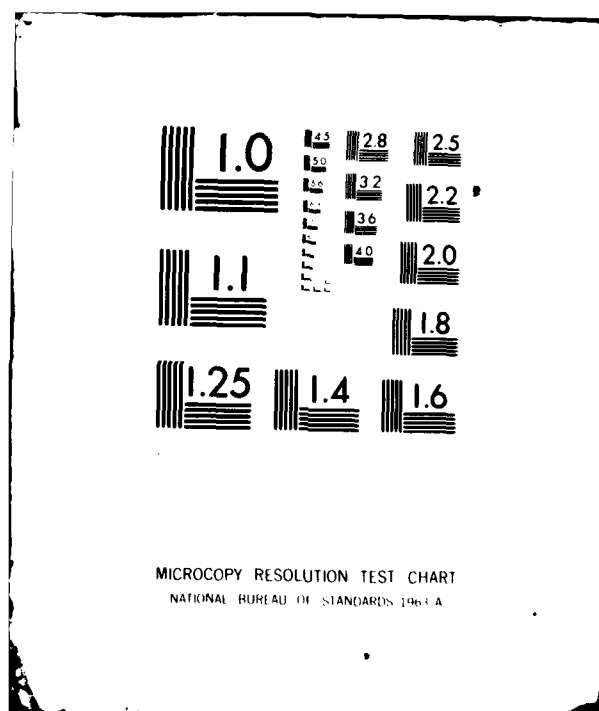
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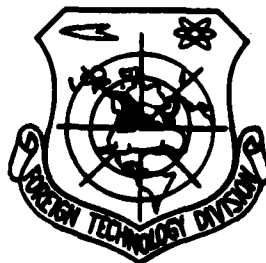


INVESTIGATION OF THE EFFECT OF OPERATION OF HIGH-VOLTAGE  
IMPULSE CAPACITOR IN MIU MODE ON ITS OPERATING LIFE

by

V. D. Besspalov, V. V. Komotop

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# U. S. BOARD ON GEOGRAPHIC NAMES TRANSLITERATION SYSTEM

Block	Italic	Transliteration	Block	Italic	Transliteration
А а	<i>А а</i>	A, a	Р р	<i>Р р</i>	R, r
Б б	<i>Б б</i>	B, b	С с	<i>С с</i>	S, s
В в	<i>В в</i>	V, v	Т т	<i>Т т</i>	T, t
Г г	<i>Г г</i>	G, g	У у	<i>У у</i>	U, u
Д д	<i>Д д</i>	D, d	Ф ф	<i>Ф ф</i>	F, f
Е е	<i>Е е</i>	Ye, ye; E, e*	Х х	<i>Х х</i>	Kh, kh
Ж ж	<i>Ж ж</i>	Zh, zh	Ц ц	<i>Ц ц</i>	Ts, ts
З з	<i>З з</i>	Z, z	Ч ч	<i>Ч ч</i>	Ch, ch
И и	<i>И и</i>	I, i	Ш ш	<i>Ш ш</i>	Sh, sh
Й й	<i>Й й</i>	Y, y	Щ щ	<i>Щ щ</i>	Shch, shch
К к	<i>К к</i>	K, k	Ъ ъ	<i>Ъ ъ</i>	"
Л л	<i>Л л</i>	L, l	Ы ы	<i>Ы ы</i>	Y, y
М м	<i>М м</i>	M, m	Ь ь	<i>Ь ь</i>	'
Н н	<i>Н н</i>	N, n	Э э	<i>Э э</i>	E, e
О о	<i>О о</i>	O, o	Ю ю	<i>Ю ю</i>	Yu, yu
П п	<i>П п</i>	P, p	Я я	<i>Я я</i>	Ya, ya

\*ye initially, after vowels, and after ъ, ы; e elsewhere.  
When written as ё in Russian, transliterate as yě or ě.

## RUSSIAN AND ENGLISH TRIGONOMETRIC FUNCTIONS

Russian	English	Russian	English	Russian	English
sin	sin	sh	sinh	arc sh	sinh
cos	cos	ch	cosh	arc ch	cosh
tg	tan	th	tanh	arc th	tanh
ctg	cot	cth	coth	arc cth	coth
sec	sec	sch	sech	arc sch	sech
cosec	csc	csch	csch	arc csch	csch

Russian	English
rot	curl
lg	log

1932

**INVESTIGATION OF THE EFFECT OF OPERATION OF HIGH-VOLTAGE IMPULSE  
CAPACITOR IN MIU MODE ON ITS OPERATING LIFE**

**V. D. Bespalov, V. V. Komotop.**

During the development of high-voltage impulse capacitors of various purpose and high-voltage impulse installations with capacitive energy storages (for magnetopulse treatment of metals, powerful storage batteries, etc.) there inevitably appears the question about how the operating life of the capacitor will be changed with the change of its operating modes (pulse recurrence frequency, current frequency in discharge circuit, degree of damping, etc.).

The correct answer to this question makes it possible to solve the problem of optimum designing of the capacitor and the installation on the whole.

Below we will examine the effect of the operating mode on the operating life of the capacitor. As dielectric we used condenser tissue of brand KON-II, 5  $\mu$  thick, impregnated with medical castor oil. Between the plates were 6 layers of tissue. Construction of the section is flat, amount of capacitance - 0.03  $\mu$ F.

The results of measurement showed that the law of distribution of failure of the investigated capacitors conforms to standard-logarithmic distribution. For obtaining reliability not less than 0.8 each experiment was repeated 22 times.

The effect of the amount of damping (relationship of the amount of voltages (or current))  $U_2/U_1$  was studied with working gradient  $E=150$  kV/mm, pulse recurrence frequency  $f=5$  Hz, current frequency in the discharge circuit  $F=100$  kHz, temperature  $t=20-25^\circ\text{C}$  in the range of relationship  $U_2/U_1$  from 0.85 to 0.3.

Fig. 1 shows the curves of dependence of the operating life on the amount of damping: curve 1 is constructed by the results of investigations conducted in Khar'kov Polytechnic Institute (KhPI), and curve 2 is taken for capacitors of the firm "Simens" [1].

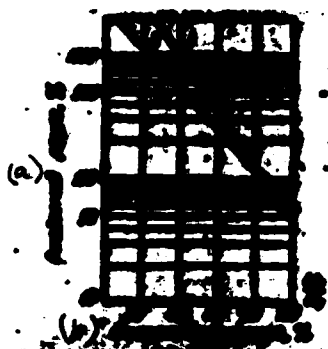


Fig. 1. Dependence of the operating life of capacitor on the degree of damping.

Key: (a) Expected operating life, o/o. (b) Degree of damping.

This dependence can be expressed by the following empirical formula:

$$M = \frac{C}{B + (U_2/U_1)^n} \quad (1)$$

where  $M$  - operating life of capacitor;  $C$ ,  $B$ ,  $n$  - coefficients, the values of which are equal to: curve 1 -  $C=1.21 \cdot 10^4$ ;  $B=0.023$ ;  $n=4.3$ ; curve 2 -  $C=0.65 \cdot 10^4$ ;  $B=0.036$ ;  $n=3$ .

From curve (1) we see that the operating life of the capacitor depends on the value of relationship  $U_2/U_1$ , and, for example, with change from damping 0.05 to 0.4 is increased almost 10 times.

The mechanism of failure of dielectric of the capacitor with polar impregnation with change of the value of the damping ratio can



probably be explained by increase of the intensity of partial discharges, similar to that which occurs during a similar situation in capacitors with impregnation by mineral oil [2].

The effect of the pulse recurrence frequency was studied in the frequency range from 1 to 10 Hz with the following initial prerequisites:  $E=150$  kV/mm,  $U_2/U_1=0.85$ ,  $F=100$  kHz,  $t=20-25^\circ\text{C}$ .

The results of experiments can be described by the following empirical formula of type:

$$M = af^b, \quad (2)$$

where  $f$  - frequency, Hz;

$a, b$ , - coefficients, which are equal to  $a=3.3 \cdot 10^6$ ,  $b=0.021$ .

Usually, in NION the pulse recurrence frequency is less than 1 Hz, therefore the relationship to frequency cannot be considered.

Some increase of the operating life of the capacitor with increase of the pulse recurrence frequency can be explained by the different time the capacitor is under voltage in the process of charge [3]. The connection between the operating life of the capacitor and the current frequency in the discharge circuit and the operating life and working gradient [4] is expressed respectively by

formula

$$M = kF^{-l}, \quad (3)$$

where  $F$  - frequency of current in the discharge circuit, kHz;

$k, l$  - coefficients, values of which are obtained from curve [1] and are equal to  $k = 4.8 \cdot 10^6$ ,  $l = 0.43$ .

$$M = A E^{-n}, \quad (4)$$

where  $E$  - working gradient, kV/mm;

$A, n$  - coefficients, values of which were found experimentally ( $A = 4.820 \cdot 10^{21}$ ,  $n = 8.00$ ).

By combining formulas (1-4), it is possible to obtain the following relationship of the operating life of the capacitor to its operating mode.

$$M = 2.25 \times 10^7 E^{-8} F^{-0.43} \left[ 1 + \left( \frac{E}{10} \right)^2 \right]^{-1}$$

where  $a, b, l, B, n$  - empirical coefficients.

Thus, a formula is obtained, which, on the one hand, during development of impulse capacitor and selection of the operating life makes it possible to consider its operating mode, and on the other hand, with the presence of a capacitor with assigned parameters to predict how its operating life will be changed with change of the

operating mode.

Fig. 2 shows the nomogram, by which we find the required operating life  $\frac{M}{M_0}$  by the assigned parameters of equation (5) (for this from  $\frac{E}{E_0}$  let us move along the vertical to  $\frac{U_A}{U_0}$ , then along horizontal to  $F_1$ , along vertical to  $f$  and along horizontal to  $\frac{M}{M_0}$ ).

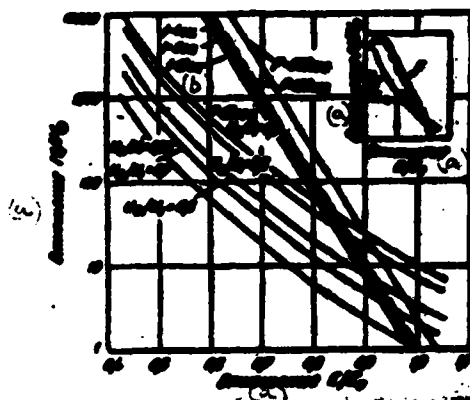


Fig. 2. Nomogram for determination of the operating life of impulse capacitor from change of its operating mode.

Key: (a) Relationship. (b) Hz.

#### REFERENCES



